

Abiotic Foliage Damage

Often affects many host species in an area

Cause—Common causes of injury or damage to foliage by non-living agents include fire, drought, frost, and chemicals.

Hosts—All tree species throughout the Rocky Mountain Region can be damaged.

Signs and Symptoms—Identification of abiotic foliage damage often requires learning the history of the site, comparing injury between trees and other plants of the same and different species, looking for patterns across the site, and ruling out damage from other agents such as diseases and insects. The factors causing these damages often operate for a brief period, but some can persist for much of the growing season as with drought.

Common damages in the region:

- **Fire** injury to foliage can be from direct burning or from radiant heat. Mortality is common, especially if stems are affected. See the Abiotic Stem Damage entry in this guide. The damage can look similar to some foliage diseases or other abiotic foliage damage, but charred or burned vegetation around the trees is often evident.
- **Drought** symptoms are usually expressed in the foliage, but drought affects the whole tree (figs. 1-2). Direct drought mortality is not common in older, well-established trees, but damage to young trees and especially regeneration is common. Drought stress is a normal phenomenon in trees when water loss by transpiration exceeds the rate of absorption from soil. In this Region, drought stress occurs frequently in mid to late summer. Direct mortality from drought only occurs when a tree's water potential falls below the permanent wilting point. Drought stress at levels that do not cause mortality can predispose trees to some diseases (especially cankers and root diseases), insects (especially bark beetles), and fire.

Symptoms of drought include reduced growth, wilting, foliage discoloration and damage, premature leaf fall, and/or early dormancy. With extreme drought, new foliage is shed, shoots die back to lateral buds, and tree mortality may occur. In conifers, common symptoms are premature browning and shedding of older needles, stunted needles, and brown tips of new foliage. In hardwoods, common symptoms include wilting, yellowing of foliage, reddish brown to brown leaf tip and/or margins (scorch), and premature leaf drop. Injury is most severe on south and southwest slopes, shallow or sandy soils, and during periods of heat and unusually low rainfall. Symptoms are similar to those of trees suffering from root, wilt, or canker diseases. With root diseases, roots die before the foliage and a root disease pathogen can be found in the roots. Trees with wilt diseases may have vascular discoloration and a wilt disease pathogen can be found in the outer xylem tissues. Canker diseases cause



Figure 1. This tree shed older needles first due to drought. Photo: Susan K. Hagle, USDA Forest Service, Bugwood.org.



Figure 2. Aspen after chronic drought. Photo: Southwestern Region, USDA Forest Service.

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the same crown symptoms when a canker pathogen girdles stems and/or branches.

- Winter desiccation injury occurs when solar warming of south and southwest tree crowns causes leaves to transpire when roots are frozen and unable to replace moisture (fig. 3). Foliar damage may be predominantly on the southwest aspect of the crown, but occasionally, damage is located more on the side of prevailing winds. The portions of crowns covered by snow are not damaged.

Winter desiccation can damage or kill conifer foliage but seldom damages the buds and branches. Needles damaged or killed often remain green when temperatures are cold, turn yellow or red-brown when temperatures increase in spring, and are shed in early summer. New foliage usually emerges in late spring or early summer. Because buds and branches usually survive, winter desiccation typically results in minor growth loss and aesthetic problems of conifers. If buds and/or branches die, multiple stems often form, resulting in a bushy tree form. Although not common, top-kill or mortality has been reported. Symptoms occur across the landscape, but individual trees vary in symptom expression.



Figure 3. Winter desiccation damages the foliage exposed above the snow. Photo: Scott Tunnock, USDA Forest Service, Bugwood.org.



Figure 4. Red belt damage on hillside in early spring. Photo: USDA Forest Service, Bugwood.org.

- Red belt is a type of winter desiccation (figs. 4-5). This damage affects distinct patches of conifers, often in well-defined horizontal bands (belts). South and west slopes are usually affected more than north and east slopes. This is a weather-related winter phenomenon on slopes where rapid temperature changes cause desiccation of foliage but rarely cause bud mortality. Red belt is believed to be caused by air inversions in valleys. A thin layer of warm air is trapped and cannot mix downward, so it continues across the slopes.

Symptoms are expressed in the spring when needles turn red-brown along distinct patches or horizontal bands. Needles can become entirely red-brown or, in less severe cases, discolored only at their tips. Upper portions of trees and the outermost foliage are most affected. Trees usually recover during the growing season with little residual effect.



Figure 5. Close-up of red belt damage. The outer foliage is usually the most damaged. Photo: Oscar Dooling, USDA Forest Service, Bugwood.org.

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Figure 6. Frost damage to buds of Douglas-fir. Photo: USDA Forest Service, Bugwood.org.



Figure 8. Frost damage with branch droop. Photo: Petr Kapitola, State Phytosanitary Administration, Bugwood.org.



Figure 9. Salt damage is evident only near the road. Photo: William M. Ciesla, Forest Health Management International, Bugwood.org.



Figure 7. Frost damage to red oak shoots. Photo: Andrew J. Boone, South Carolina Forestry Commission, Bugwood.org.

- Frost or freeze injury occurs in the spring when susceptible new foliage or young shoots are exposed to sudden freezing temperatures (figs. 6-8). Greatest vulnerability is from bud break to final shoot and leaf elongation. The extent of damage depends on the stage of development at the time of frost. New leaves and shoots are often killed, especially during earlier expansion. Damage frequently occurs on several species in an area.

Within a day or two of freeze injury, foliage and shoots become limp and begin to fade to yellow.

Damaged tissues at first appear water soaked. After a week or more, tissues become shriveled; foliage turns reddish brown, dark brown, or black, depending on the species, and can droop; and young shoots turn brown and can droop. Dead buds become dark brown in the interior. Dead leaves and shoots eventually break off or abscise during the next few weeks. New shoots and leaves begin to grow almost immediately.

- Road salt is a common type of chemical damage (fig. 9). Salt can affect the foliage indirectly through root absorption or directly when salt spray settles on trees near high-speed roads. Damage can occur wherever chlorides (sodium, calcium, or magnesium) are applied for deicing in the winter or dust abatement in the summer. Most of the time, symptoms are insignificant and injury is very close to a road. Symptoms may be severe along highways where large quantities of salt are used. Symptoms can also occur in low areas where salts accumulate after runoff. Plant tissue can be analyzed in a laboratory to determine the amount of salt present. Symptoms can differ between the two entry methods.

Root uptake damage is evident after spring thaw in conifers in second-year needles and soon after budbreak in hardwoods. Burn of needle tips, with the bases of needles remaining green, is common in conifers, and browning of leaf margins is common in hardwoods. With higher salt concentrations, buds will break with reduced foliage, more pronounced tip burn or brown leaf margins develop, and trees have reduced growth. Symptoms can intensify

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Figure 10. Herbicide damage on pine. Photo: Susan K. Hagle, USDA Forest Service, Bugwood.org.



Figure 11. Distorted shoots due to herbicide damage on pine. Photo: Minnesota Department of Natural Resources, Bugwood.org.



Figure 12. Herbicide damage on hardwood species. Photo: Joseph O'Brien, USDA Forest Service, Bugwood.org.

through the season with 1-year-old needles showing symptoms mid-winter and premature leaf drop of the 2- and 3-year-old needles in conifers. Symptoms of severe damage include delayed or lack of bud break and branch or tree mortality.

On conifers, tip browning from salt spray is common, and browning can progress toward the base of needles throughout the growing season. Salt spray in hardwoods often results in mortality of terminal buds. This mortality can result in bud break of several lateral buds, causing brooms. Unlike damage caused by root uptake, marginal browning rarely occurs with salt spray on hardwoods.

- Herbicide damage is another type of chemical damage (figs. 10-12). Herbicides can affect foliage directly or indirectly through root uptake. Herbicide damage often follows a pattern consistent with application of the chemical, such as a swath about the width of a spray boom where weeds were sprayed. Weed treatment areas include: along roads, rights-of-way, fuelbreaks, or around dwellings. In many situations, plant samples can be submitted to a laboratory to determine the amount and type of chemical in the tissue.

Symptoms vary by chemical. Preemergence: photosynthetic inhibitors (simazine) can cause leaf yellowing. Postemergence: growth regulators (Glyphosate) can cause abnormal leaf development, tip yellowing, and dieback; Picloram (2,4-D) symptoms are similar to glyphosate and also include twisted petioles and shoots. Contact (Paraquat) injury results from drift, causing small dead spots on foliage. High concentrations of any of these herbicides can cause mortality.

Impact—Losses in the Region from abiotic foliage damage are usually minor compared to those caused by diseases and insects, with the exception of fire. Most biotic diseases and insects affect a single tree species or group of species. Abiotic agents often affect various tree, shrub, and herbaceous species in an area. However, some tree species are more resilient to some of the damage agents.

Extensive damage from any of these agents can result in growth loss or stunting. However, abiotic foliage damage rarely causes direct mortality, with the exception of fire and, in extreme cases, herbicide damage. Stress associated

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with these damages can make trees more susceptible to some diseases (especially cankers and root diseases) and insects (such as wood borers and bark beetles), which can result in mortality.

Management—There are few management options for many of the abiotic foliage damages, with the exception of fire, drought, salt, and herbicide damage.

Fire management should include elements of fire prevention and fire suppression. Because many fires are caused by people, educating the public is the best option. Methods that reduce the spread of fires such as reducing fuel loads, thinning stands, and creating firebreaks will reduce the number of trees damaged. After fire, prompt salvage cuts can be used to remove trees of value before they are colonized by decay fungi and wood borers, if consistent with management objectives.

For drought, management of competing vegetation, stand thinning, planting techniques that reduce drought, and selection of a tree species compatible with a site will reduce losses.

For road salt, prudent use will reduce losses. To reduce over-application, machines should be calibrated to apply the optimum level of salt for reducing surface ice or dust in order to not apply excessive levels. Mortality can be high when salts are applied for dust abatement before heavy rainstorms, so this should be avoided. In areas where trees are planted along roads, salt-tolerant species could be used. The amount of salt damage is directly related to the distance from a road, with the exception of salt runoff in limited downhill areas. Therefore, planting trees farther from the road or cutting trees near a road will reduce salt damage and also improve visibility.

To reduce herbicide damage, read the label and apply the chemical as directed. Also, check and properly calibrate equipment. Select herbicides that will do the job but pose the least risk to trees in the area. Tree species vary in tolerance to some herbicides.

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